

GENERAL CONSIDERATIONS AS TO THE TREATMENT OF WAR WOUNDS*

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AMONG the important scientific contributions which have been produced in the course of this war, those which pertain to surgery have been, perhaps, the most characteristic and the most productive of important results. They have impressed upon the treatment of wounds a new evolution which will make an epoch in surgery.

Observation has shown us in the first place, contrary to what had seemed to be established by previous wars, that in the great majority of cases wounds are infected, or, at least, contaminated. In consequence of this first dictum débridement became to all surgeons a formal indication of the first rank. In general, all wounds inflicted by war fragments or from grenades, as well as the wounds by shrapnel or of bullets, which produced serious lacerations in the interior of the tissues or were accompanied by an abundant bloody effusion, were freely opened up immediately upon the arrival of the wounded at a hospital organization sufficiently equipped. At the same time the contused and lacerated tissues which constituted a medium favorable for microbic growth were cut away with the greatest care so that there was effected a veritable "*épluchage*" of the wound before proceeding to its dressing.

As a complement to this surgical intervention, surgeons had recourse for awhile in grave cases to cauterization by the thermocautery, or by superheated air or by the application of a chemical. These various agents, however, were given up because of their unduly violent action.

Since January, 1915, we have followed at l'Ambulance de l'Océan débridement and *épluchage*, with primary suture, when the cases appeared to us favorable, or we have resorted to secondary suture, as soon as after their dressing the surfaces of the wound appeared to be clinically aseptic, although we did not possess at that time any formal index as to the evolution of the microbial flora in a wound, so that it was not possible for us then to build up a systematic method of procedure. The merit of having systematized scientifically the secondary suture of wounds belongs to Alexis Carrel, who at the beginning of the war put himself at the disposition of the *Service de Santé* of the French Army and was put in control at Compiègne of an experimental clinic of 80 beds. With the help of the chemist Dakin, Carrel sought for an agent capable of destroying the microorganisms in the depths of wounds, more efficient than any of the agents which had up to that time been recommended.

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After a very minute study made by Dakin as to the relative value of a large number of antiseptic agents, Carrel chose the hypochlorite of soda which even in dilute solution has the great property of conserving the proteins and of preserving also its antiseptic power in the presence of blood serum and organic exudates. The great inconvenience of the sodium hypochlorite was its caustic action upon the tissues and particularly upon the skin. Dakin remedied this by preparing a solution of the hypochlorite of a determined strength perfectly steady and by neutralizing it with boric acid.

I need not detail here the preparation of the Dakin solution. I will dwell only upon two points.

1. The solution must be fresh, prepared from day to day.
2. Careful verification must be made as to its reaction and all preparations must be rejected which are not absolutely neutral.

But the method of Carrel does not consist alone in the choice of the solution of Dakin for the irrigation of wounds. The way in which this solution is employed constitutes an essential point of the method. The different steps of the method as finally used by us may be stated as follows:

1. Beginning with the admission of the patient in the hospital, the injured region is shaved and washed carefully with a neutral solution of oleate of soda.

2. Débridement and épluchage of the wound are practised immediately thereafter.

3. At the same time are installed the Carrel tubes which are introduced to the bottom of the wound in such fashion as to permit the irrigation of the entire wound surface.

4. Application to the entire surroundings of the wound of compresses smeared with vaseline in order to prevent irritation of the skin.

5. Dressing with compresses of absorbent material.

6. After the return of the patient to bed, the Carrel tubes are connected up with the receptacle containing the Dakin solution and irrigation is carried on every two hours, controlled by a simple pressure forceps of Mohr.

7. The dressings are renewed every day and in the course of each one of them, careful lavage of the wound is made with oleate of soda. One must not permit to remain upon the skin about the wound the slightest concretion, for they always hide colonies of microbes.

However, it was not possible for us to judge the method of Carrel at its true value and to derive from it all its benefits until we were able to follow the evolution of the wound by methods of bacteriological control.

This control was a most valuable element in the method of Carrel. It consists in the regular determination of the abundance of the micro-organisms in the wound exudates.

To carry it out there is made a simple smear according to the usual

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laboratory methods, in which are counted the number of microbes contained in the microscopic field. This bacteriological control was established in a systematic way in our hospital from the beginning of June, 1916. Every two days it was repeated in the same wound. At one time it was being applied in more than 500 patients at a time. For the purpose of being able to follow at a glance the progress of infection in a wound, we have made tracings of the microbic strength. We have made use for this purpose of charts of a special model, resembling temperature charts.

In a general way the microbic curve followed a characteristic line. On the entry of the patient in the hospital or when the wound had just been opened up, the chart indicates in the majority of cases no microbes. At this time the wound is only contaminated, and the infection has not spread over its whole surface. On the second day the chart shows a sharp ascent in the microbic growth and holds itself at high level for some days. In severe infections there may be counted 100, 200, even 1000 microorganisms in a visual field. The line undergoes afterwards more or less oscillations, the progress being more or less downward until the zero point is arrived at after the lapse of a variable time according to the character of the lesion or the nature of the infection.

Sometimes the wound is maintained sterile from the first day, the microbic track following the horizontal line to zero.

The infected wounds were rendered sterile by the Carrel treatment in from six to eight days.

Other solutions recommended for the same purpose gave in general a sterilization more slow and less certain. Certain agents, as flavine, seemed to produce a rapid sterilization in a way more efficient than the Carrel, but generally the results were not stable in their sterilizing power, because they disturbed the granulation of the wound and favored secondary infection.

In the cases of infected fractures the line descended permanently to zero, only after fifteen days to one month. Osseous wounds were sterilized moreover with difficulty. It was the same also with articular wounds. Whenever a sequestrum was present, it was necessary to take it away before definitive sterilization of the wound could be obtained.

The wounds which were soiled and irregular were sterilized more slowly than simple wounds. The bacillus perfringens (gas bacillus) and in general all microbes producing gaseous gangrene did not alter the course of the curve. These microorganisms disappeared rapidly from the wound whenever it was freely opened up and freely pared. Staphylococcus persisted longer. In cases of staphylococcus infection the zero point was arrived at very slowly and very often the infection persisted notwithstanding the treatment.

In fact, bacteriological evolutions in a wound may be considered in three periods:

1. The period of acute infection of variable duration in course of which the microbes are very numerous and present a maximum degree of virulence.

2. The period of attenuated infection during which the curve follows a descending course and corresponds to an attenuation of the microbial virulence.

3. The period of sterilization which is indicated at a line horizontal with zero.

Our collaborator Govaerts has shown that these three periods of microbic infection correspond to three periods in the organic reaction of tissues.

1. During the period of acute infection there are then only polynuclear elements in the wound exudate.

2. In the later course of the microbic disease the polynuclear elements disappear and there are found in the preparation mononuclear elements which become more and more numerous. At the end of this period macrophagi begin to appear.

3. In the course of the period of sterilization there exists in the preparation in the macrophagi.

Evidently, gentlemen, we do not attribute to the microbic curve an absolute value, but in the majority of cases its practical value is the real one, for it permits us to follow the evolution of the infection in the wound and indicates the moment when suture may be practised with the greatest probability of success.

Experience has shown us, nevertheless, that it is necessary to take into account in deciding the moment of suture, not only the quantity of infectious agents present, but their quality and from this point of view was recognized:

1. That wounds slightly or moderately infected by ordinary microbes may be sutured without danger and with every chance of success.

2. That the presence of staphylococci does not contraindicate suture.

3. That the perfringens remain enclosed in the wounds only a very short time, but as long as these microbes do not disappear it was dangerous to resort to suture.

4. That a wound should not be sutured when there was even a slight streptococcic infection.

For the purpose of specifying more exactly the microbic flora of the wound and of determining better the moment most favorable for suture, we have thought it useful to supplement the counting of the microbes upon the smears subjected to bacteriological examination by cultures instituted regularly after the débridement and before the suture. We have to this end adopted a more complete microbic chart, proposed by Doctor Levaditi of the Pasteur Institute, who has devoted himself especially with us to the study of the infection of wounds.

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The conclusions as to suture up to the present moment have been as follows:

(a) For wounds feebly infected from the first day with ordinary microbes by proceeding to suture when at the second examination the smear yields only one microbe in a visual field.

(b) For wounds strongly infected by ordinary microbes, resort to suture from the moment when the curve came down to one microbe in four fields.

(c) For streptococcic infection never to suture but to submit the wound to adequate treatment, preferably that of Carrel, and to wait until the streptococci had disappeared, or had become attenuated sufficiently to permit primary union.

Streptococcic vaccination may render here the greatest service. The researches made in our hospital by Doctor Levaditi leave no doubt on this point.

Such, gentlemen, are the most important general rules which in our opinion should guide us to-day in the treatment of war wounds, and which have as their object the production of a sterilization of the wound sufficiently complete to make successful suture possible.

Immediate primary suture may be made immediately after débridement or it may be made from two to four days after débridement.

Delayed primary suture, or early secondary suture. In this latter case is done as is primary suture, without refreshing of the wound surfaces by simply approximating the surfaces. Finally, the suture may be made in the course of the granulation of the wound when sterilization has been sufficiently assured.

Secondary suture. This always necessitates the refreshing of the wound surfaces by which step it is distinguished from the preceding methods of suture.

The immediate suture is indicated in cases where the clinical aspect of the wound after débridement and épiluchage gives a guarantee of sufficient sterilization. It may be resorted to especially:

1. In wounds of joints, and in general, in wounds of serous cavities.
2. In wounds of the cranium, of the face, of the hand and of the foot, where the abundance of vascularization, both blood and lymph, warrants a surgeon in making immediate suture as a rule.
3. In superficial wounds of the soft tissues in certain fractures without comminution. This suture has the advantage of offering anatomical repair of the tissues, but infections, when they take place, are always rapid and grave, involving diffuse phlegmonous and gaseous gangrene.

Late primary suture or early secondary is indicated particularly for wounds involving soft tissues only and for some open fractures. It is done after bacteriological control has been made as described above. Late primary suture rarely fails of success on account of grave accidents.

Late secondary suture is reserved for wounds which can not be sutured

during the first days, because of too extensive destruction of tissue, or because of the development of infection. It offers the great advantage of giving complete security, but it delays the healing and does not always give as perfect an anatomical restitution as the other forms of suture.

There remains now for examination the problem of the treatment of war wounds from more special points of view, and of considering the peculiarities which arise from the organ or the tissue wounded.

We shall examine in succession:

Wounds of the cranium.

Wounds of the face, of the hands and the foot.

Wounds of the soft tissues.

Amputation stump wounds. Fractures.

Joint wounds.

Wounds of the chest.

Abdominal wounds.

We shall limit our discussion to general indications.

Wounds of the Cranium and of the Hairy Scalp.—When we have to deal with a wound of the hairy scalp, limited to the soft parts, we cut away the margins of the contused surface and suture them immediately. When the cranium is wounded without an opening in the meninges, we practice regularly trephining in order to take away the fragments in the internal table which are practically always present and, as in the case of wounds involving only the hairy scalp, we finish with immediate suture.

When a wound of the brain has taken place two complications are feared: 1. Cerebral hernia. 2. Meningo-encephalitis, that is to say, infection of the meningo-encephalic spaces.

The hernia is the result of the œdematous and blood congestion of the cerebral substances during the first hours which follow the traumatism. It corresponds to the swelling of the external features in wounds of the face, but with this special feature that encephalic congestion drives to some degree the cerebral contents out from the cranial box. Once established, the cerebral hernia invites infection and favors its development by the spaces which are created beneath it and which it is impossible to keep aseptic. We find ourselves then always in the presence of a vicious circle, the continuity of which it is often difficult to break.

Therefore, in treating a wound infection the surgeon should always seek to hinder the production of the hernia. Dressings which produce compression are from this point of view indispensable above all on the first days.

The ideal treatment consists without doubt of disinfection at a single sitting of all cerebral lesion and in immediate closure of the wound, but the experience at our hospital has been that wounds of the brain are contaminated or infected by the projectile in the proportion of 55 to 60 per cent., and that it is not possible to render them sufficiently aseptic at

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a single seance by any means at our disposal. Therefore, the immediate closure of the cranial breach has been attended with danger in a number of cases.

In determining the course it is necessary to be guided by the microbic curve and to resort either to late primary suture or to early secondary, or to secondary suture more or less late, if a sterilization is more or less late in being accomplished.

Wounds of the face have this in particular, that they involve vascular regions not favorable to the development of gaseous gangrene and to infection in general, they may with all certainty be brought together by immediate suture in most cases. Moreover, the retractions which inevitably follow in a wound of the face left open for a certain time often prevent apposition of the skin when a secondary suture is made and produce deformities more or less marked. It is then a matter of importance to close wounds of the face as early as possible.

When the lesion is superficial and the soft tissues alone are involved, cutaneous flaps may be formed and the suture definitely accomplished at the same seance. Complicating fractures of the jaw do not constitute an obstacle to the immediate suture. The specialist may generally succeed in manipulating through the reconstituted buccal cavity the prothetic apparatus which is necessary to hold the fragments in coaptation. If the mass of the face is widely destroyed, the skin should be brought over it as far as possible so as to prevent retraction, and æsthetic repair of the face should be accomplished later by rhinoplasty, cheiloplasty, or other autoplasic processes.

Wounds of the Hand and of the Foot.—It is important here, likewise, to suture the wounds as early as possible in order to prevent retractions and to lessen the losses of functional power which may follow. But though immediate reunion may practically be possible in all superficial wounds where they are limited to the hand and to the foot, it is not always so when the destructions of tissue have been great. Infection in these cases is often difficult to overcome because of the multiplicity of the cellular spaces and the complexity of the joint cavities which often connect with each other. To secure their sterilization it is necessary to widely open the wound throughout its whole extent, and for this purpose resection and wide arthrotomies are often indispensable.

We have operated during the period from June, 1916, to November, 1917, on 523 wounds of head, face, foot and hand which have resulted as follows:

- (a) 491 Immediate sutures which have given:
 - 473 Complete successes, viz. 96.3 per cent.
 - 8 Partial successes, viz. 1.6 per cent.
 - 10 Failures, viz. 2.1 per cent.
- (b) 18 Late primary sutures which have given:
 - 18 Complete successes, viz. 100 per cent.

(c) 64 Secondary sutures which have given:		
58 Complete successes, viz.	90.6 per cent.	
4 Partial successes, viz.	6.2 per cent.	
2 Failures, viz.	3.2 per cent.	

Wounds of the Soft Tissues.—Superficial wounds of the soft tissues lend themselves generally well to immediate suture, and according to the more or less large extent with which the processes of débridement and épluchage have been resorted to we may determine the indications of the wounds in a large measure. It would be dangerous, however, to go to too great an extent in this direction, for immediate suture does not permit any bacteriological control, and very often the perfringens bacillus and the streptococcus are there, only awaiting a favorable occasion for their development.

One should not lose sight of the fact that in delaying the suture in order to permit of a preliminary bacteriological examination one does not practically prevent the healing. If, in fact, the wound is sterile at the beginning, the microbic test will show it and one can practice the late primary suture on the second, third, or fourth day, with every certainty of success. If, on the contrary, infection persists after the débridement and the épluchage of the wound, it has been to the interest of the wounded man that the microbic curve has been established and that the suture should be done secondarily after sufficient sterilization.

However, it may be accepted as a general rule that primary suture of a wound should not be the rule:

- (a) When the lesion dates back more than eight hours.
- (b) When the patient has been already subjected to previous surgical examination.
- (c) When the lesions involve deeply the muscular masses and when the tissues are much soiled and lacerated.

As we have seen, secondary suture is done by bringing the margins together after refreshing and removal of the cicatricial film. The granulations are left in place; they do not hinder the union by first intention.

When the wound is irregular, in certain cases the irregularities may be overcome by dissecting the granulations without and within, so as to turn them over upon themselves. Moreover, the muscles may be dissected and sutured to their fellows. Care should always be taken to suture the aponeuroses in order to prevent later muscular hernias. If very strong tension of the skin is present, it is necessary to make more or less extensive slidings thereof. Sometimes one must proceed to a cutaneous débridement. Quite often we have had recourse to grafts after the Italian method, or to epidermic grafts, or often to the "greffe en culbute," which consists in cutting the cutaneous flap at a distance more or less great from the wound and bringing it to the wound by successive steps, turning it over upon itself.

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The number of wounds of the soft tissues which have been treated during the period from the month of June, 1916, to the month of November, 1917, has been 1447, the outcome of which has been as follows:

- (a) 380 Immediate sutures with:
 - 317 Complete successes, *viz.* 83.9 per cent.
 - 24 Partial successes, *viz.* 6.3 per cent.
 - 39 Failures, *viz.* 29.8 per cent.
- (b) 222 Late primary sutures with:
 - 207 Complete successes, *viz.* 93.2 per cent.
 - 8 Partial successes, *viz.* 3.6 per cent.
 - 7 Failures, *viz.* 3.2 per cent.
- (c) 845 Secondary sutures with:
 - 724 Complete Successes, *viz.* 85.6 per cent.
 - 70 Partial successes, *viz.* 8 per cent.
 - 51 Failures, *viz.* 6.4 per cent.

Amputation Stump Wounds.—When a surgeon amputates a limb, he should never forget that the stump is to support later an artificial limb. This idea is so often lost sight of in the course of amputations that I feel that I should insist upon its importance. The surgeon uses all his skill in fashioning a fine flap which carries the suture line upon the side, but he takes no account of the length of the arm for leverage to which an apparatus may be fitted. The immediate operative result occupies his mind only, while he leaves to the orthopædist the care of the prothesis without troubling himself with the importance that he should furnish to the latter a stump easy to equip.

It is, nevertheless, proper to remark that formerly the bearing of prosthetic appliances was at the end of the stump, and that therefore a lateral scar had its reason for being, but most modern apparatuses take their point of bearing over the whole surface of the stump and leave the extremity free from any contact whatever. The result is that the apparatus now used are more appropriate for a terminal cicatrix than for a lateral cicatrix, and that they may often be put in place before cicatrization is entirely completed. Adherent scars when they are terminal do not otherwise constitute an obstacle to the prothesis, and in making the decision it is always the length of the arm of the lever which should take precedence over the qualities of the cicatrix.

From another standpoint we formulate three essential considerations which should cause us to reject primary suture in a great number of cases of amputations for war wounds.

(a) It is necessary to act quickly and to seek first, above all, to save the wounded man's life.

(b) Primary union is difficult to secure. The stump wound being generally infected, its immediate closure is sure to produce great complications.

(c) It is necessary to amputate as low as possible, often through a traumatized area, in order to leave the bone as long as possible.

Guillotine amputations are from this point of view the most favorable. They give, after repair of the stump, a lever arm longer than amputations after primary suture with a flap, the fact being that such suture rarely succeeds and if done it is necessary to intervene a second time.

We have made since June, 1916, to November, 1917, 31 secondary sutures after amputation which have given 26 complete successes, 4 partial successes, and 1 failure.

Open Fractures of the Long Bones.—The objective toward which we direct the surgical treatment of open fractures apart from the orthopædic treatment, is the transformation of an open fracture into a closed fracture. To this end:

(a) Musket-ball fractures with through and through wounds, with small orifice of entry and of exit, without swelling and without lesion of the great blood-vessels, are treated aseptically and are simply immobilized in an apparatus with extension. The patient is watched closely for the first week and if accidents of infection develop, the fracture is operated upon.

(b) Other fractures are operated upon at once. The wound is opened up by an incision sufficiently wide to permit of a deep exploration of the entire wound area surrounding the fracture; at the same time excision of the lacerated soft parts and extraction of foreign bodies is accomplished. Free bony fragments are taken away with care, pointed bone ends which threaten the vessels and the nerves are resected, but care should be taken to preserve as far as possible a bony bridge between the fragments in order to favor consolidation.

The wound is then sutured immediately either by late primary suture or by secondary suture according to the seat and extension of the lesion and the gravity of the infection.

Immediate suture is attended only in cases very exceptional which present a minimum of soft tissue, as the humerus and forearm. It is never practised in the course of an offensive and is contraindicated in wounds of the soft tissues when the wound dates back more than eight hours, or if a wound can not be kept under the same surgical oversight.

Primary delayed suture or early secondary suture is practised when the microbic curve present shows a sufficient sterilization from the beginning of the treatment.

Late secondary suture is the most frequently resorted to. It may be used as soon as the Carrel treatment has obtained the clinical sterilization of the lesion, that is to say, from fifteen days to a month, unless the infection has been due to streptococci. In the event of this last accident, suture may be delayed for several months.

The treatment which we have just sketched and which consists in transforming the open fracture into the closed fracture shortens much the time necessary for cure and guards the patient from the complications produced by prolonged immobilization.

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We resort to amputation in case of fracture only in extreme cases. Experience has shown us that one can by careful application of the method of Carrel preserve limbs which in former times would have been considered irremediably lost.

The number of fractures operated in our service from May, 1916, to November, 1917, has been 191, divided as follows:

(a) Fractures of the femur, 43, of which there were 4 primary sutures with 4 cures, *viz.*, 100 per cent.

Under delayed primary suture

39 Secondary sutures which gave:	
30 Complete cures, <i>viz.</i>	76.9 per cent.
7 Partial successes, <i>viz.</i>	17.9 per cent.
2 Failures, <i>viz.</i>	5.2 per cent.

(b) Fractures of other bones: 148.

26 Primary sutures with:	
20 Complete cures, <i>viz.</i>	76.9 per cent.
3 Partial successes, <i>viz.</i>	11.4 per cent.
3 Failures, <i>viz.</i>	11.34 per cent.

20 Delayed primary sutures with:	
16 Complete successes, <i>viz.</i>	80 per cent.
4 Partial successes, <i>viz.</i>	20 per cent.

102 Secondary sutures with:	
92 Complete successes, <i>viz.</i>	90 per cent.
3 Partial successes, <i>viz.</i>	3 per cent.
7 Failures, <i>viz.</i>	7 per cent.

Joint Wounds.—Under the head of joint wounds, we simply include those of the large joints, as of the knee, of the hip, of the elbow, and of the shoulders. In general, an articulation kept open becomes infected notwithstanding the most daily care. On the other hand, the immobilization to which the limb is subjected added, to the constant irritation of the joint surfaces by the secretions with which they are bathed determines the presence of adhesions and ankyloses.

During the first period extending from December 20, 1914, to September 10, 1915, we treated joint wounds by the system then in use everywhere, which consisted in the drainage of the cavity, the dressings being renewed several times a day at each of the dressings to irrigate with an antiseptic solution, such as oxygenated water, formalin water, carbolated water, etc. The limb was immobilized either by means of an interrupted apparatus (bridged) or by means of a gutter. The results were frankly bad. At this time the wounds of the knee-joint were considered as the gravest in character in war surgery.

During a second period, extending from December 10, 1915, to July 1, 1916, we applied the method of Carrel after débridement of the wound. The results were a distinct improvement over those of the first period,

but they were still not very brilliant. They demonstrated to us, especially for the knee, that the method of Carrel was not sufficient to make certain in a dependable manner the practical sterilization of a joint cavity.

Since the month of July, 1916, we have resorted to wide arthrotomies with immediate closure of the joint whenever possible.

From the month of May, 1916, to the month of November, 1917, we made:

(a) Sixty-six immediate sutures for wounds of the large joints without bony lesion. Of these there were 62 cures, *viz.*, 95.7 per cent.; 4 failures, *viz.*, 6.1 per cent.

(b) Seventy-nine immediate sutures for wounds of the large joints, with bony lesions. Of these there were 71 complete successes, *viz.*, 89.8 per cent.; 1 partial success, *viz.*, 1.2 per cent.; 7 failures, *viz.*, 7.0 per cent.

These results show indisputably the superiority of immediate suture after wide arthrotomy, closing of the joint cavity, over any other method of treatment. It is necessary, however, not to lose sight of the fact that conditions do not always favor a primary suture at the elbow and at the shoulder. In wounds of these regions, in fact, the soft tissues are often so torn that it is impossible in many cases to secure apposition in the wound borders. The Carrel treatment followed by secondary suture or by cicatrization by second intention is evidently indicated in such cases.

On the other hand, the results of resections are not the same for the elbow and the shoulder joints, as for the knee-joint. In the two first, resection results in articular mobility, while in resecting the knee the movements of the joint are in great measure destroyed. Therefore, for the shoulder and the elbow, one easily decides to do a resection, when one shuns it at all hazards in cases involved in the knee. Aside from cases in which there was a simple through and through wound with minute orifices which healed spontaneously, the treatment of choice of numerous war wounds involving a joint consists in a wide opening of the joint, a careful cleansing of the cavity, curettage of the osseous surfaces, if they are injured, and the immediate suture of the wound, with or without drainage. Immobilization is de rigueur from six to eight days.

The Carrel treatment is indicated in joint wounds with extensive lesions of the soft tissues which do not allow approximation of the skin, which is often the case at the elbow and at the shoulder. However, in these cases the attempt may be made to close the fracture primarily by means of a sliding of skin or by an autoplasty. Finally, a resection is justified in extensive lesions of the bony ends, but it is necessary not to lose sight that typical resection, particularly at the elbow and at the shoulder, promise better results from the point of view of function than an uncomplete operation leaving an osseous callus at the lower part of the articular cavity.

There remain, then, two questions for consideration with regard to joint wounds:

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(1) When a purulent infection of an articulation has taken place, how should it be treated?

(2) Joint resection having been judged necessary, is it necessary to follow it with primary suture, or is it better to resort to secondary suture?

(1) The first question has been answered by Doctor Willems who, cutting loose from ancient prejudices, has replaced immobilization by active mobilization. The movements to which a joint is subjected when they are executed by the patient are not painful, and the results produced by this mode of treatment are really remarkable. The suppuration diminishes rapidly and infection disappears and the joint mobility is preserved, even when infection has been profound, with relatively considerable tissue destruction. It is proper to remark, however, that the mobility can give its full return only when its application is watched over by a competent surgeon.

(2) As to whether it is better after articular resection for a war wound to make primary suture or secondary suture, the conditions will vary according to the joint affected. For the elbow and the shoulder, as a rule, it is better to make immediate suture for the end of preserving movement, but as our experience has demonstrated, such a result can rarely be realized. In a large number of cases we have had to resort to secondary suture, or often to permit the wound to heal by secondary intervention.

After resections of the hip and especially after those of the knee, primary suture is dangerous. On account of the impending infection, it is better to leave the wound open, to keep the bony surfaces separated by apparatus, to sterilize the wound according to the method of Carrel and to complete the surgical treatment by secondary suture.

Chest Wounds.—Taking up next the question of the closure of penetrating wounds of the chest, that is to say, open pneumothorax. When the thorax is opened, the air rushes into the pleural cavity and the lung contracts upon itself with the result that there is a disturbance of the respiratory equilibrium which may go on even to asphyxia, syncope, and finally death. Generally, however, the respiration becomes reestablished and regular after a certain time through the coöperation of the lung on the sound side. The lung on the wounded side remains contracted in a state of collapse; after a time it loses its elasticity and becomes fixed after a fashion in its new position.

As the result of the inflammatory reaction of the pleura, there is formed a fibrinous layer more or less thick, which encloses the lung and is the source of the impossibility of the lung undergoing physiological expansion. There is thus established between the lung and the parietes a separate cavity which necessarily persists as long as the lung can not be brought into apposition with the thoracic wall. In order to accomplish this have been advised the operations of Estlander, of Schede, of Delorme, and the one which we ourselves have recommended to depress the wall of the thorax by a massive resection of the costal wall.

The general considerations that we have just stated show how important it is to close the thorax immediately after the wounding. The rules which have been adopted by us at our hospital are based essentially upon the idea of securing the suture of the parietes. They are as follows:

(1) If the thorax is widely opened and the lesions recent, and there is persistent hemorrhage from the lung, the indication is to apply hæmostatic suture to that organ, although if the flow of blood is very abundant and the condition of the wounded man is very threatening a tamponade of the pulmonary wound must be resorted to. In order to close the pleural cavity if it is not possible to close the thorax breach by reason of its extent or because of the menace of infection, we apply a special tampon that we have designed which we call "*tamponnement en bouton de chemise*" (shirt button tampon), which makes certain the hermetic sealing of the cavity at the same time that it permits drainage.

The use of local anæsthesia in the course of intervention and in the later dressings is most useful.

(2) If the orifice is narrow but still permits the air to enter, it is necessary as soon as possible to obtain its secure closure in order to stop the progress of the pneumothorax. It should be well understood, however, that, in cases of hemorrhage of the lung a preliminary enlargement of the pleural opening may be necessary in order to treat the pulmonary wound. Occlusion of the thoracic wall is accomplished by the suture *en masse* of the musculocutaneous planes.

(3) If there is present an open pneumothorax, with an already developed pleural infection, the treatment of Carrel is instituted in all cases and as soon as sterilization of the wound has been accomplished the cavity is closed by suture in the musculocutaneous spaces.

Before proceeding to closure it is indispensable to control the sterilization of the pleura by cultures from the exudate. It is necessary, moreover, that the pleural secretion should have become completely dried up. It is only in these conditions that operation may have any chance of success and that it will replace definitively all those methods of intervention, which in order to bring the lung and the parietes into apposition demand more or less resections of the costal wall.

Wounds of the Abdomen.—In order to complete our report, we should now speak of suture of the wounds of the abdomen, but such general accord has been established that all surgeons think that early intervention should be resorted to. For the end of permitting us to intervene as early as possible in abdominal lesions; lesions of the thorax or in cases of severe hemorrhage we established at a distance of 2 or 3 kilometres from the front, advanced dressing stations sufficiently well equipped to make possible interventions of urgency. The installation of these posts reduced the mortality in wounds of the abdomen from 65 per cent. to 45 per cent.